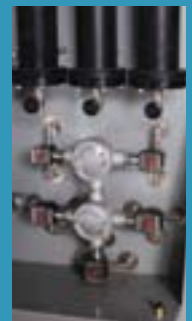




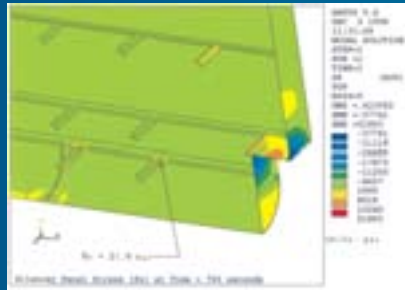
# Braden Systems for Gas Turbines



**BRADEN  
MANUFACTURING, LLC**  
A GLOBAL POWER EQUIPMENT GROUP COMPANY

Challenge Us To

# Design & Engineer



## Braden...The GT OEMs' First Choice

For the last 40 years, Braden Manufacturing has occupied a unique spot halfway between the gas turbine OEMs and power producers. No other company has spent more time listening, learning, and working with both groups.

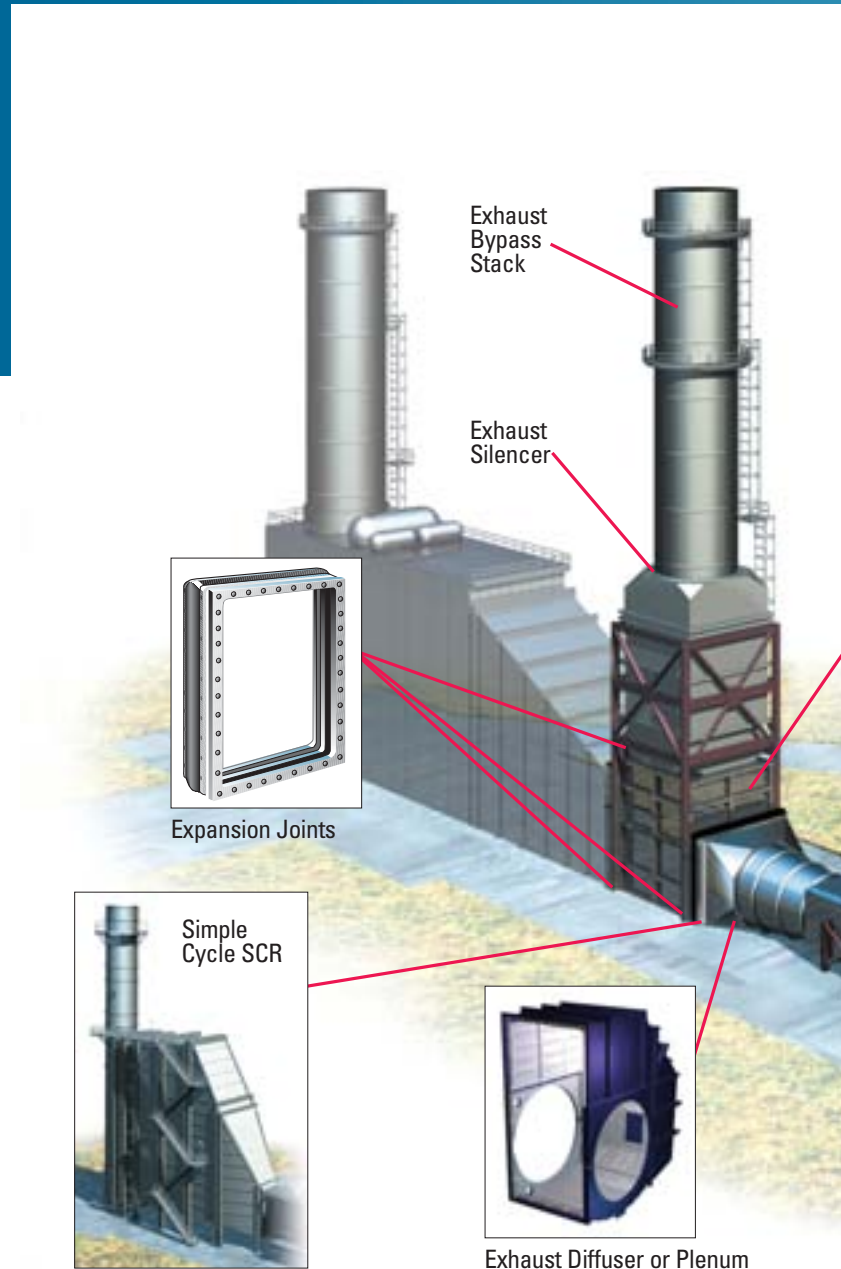
As a result, Braden has established itself as the most experienced and trusted name in the design of auxiliary systems for GT power plants. Turbine manufacturers acknowledge that no other company is better equipped to handle the challenges of GT plants:

- Air Filtration
- Inlet Cooling / Heating
- Silencing
- Exhaust & Inlet Ductwork
- Diverter Dampers
- Simple Cycle SCRs
- Expansion Joints
- Bypass Stacks
- Diffusers & Plenums
- Installation provided by Williams Industrial Services
- Inspection & Reporting Services

## Site-Specific Design Goals

Every project begins with careful listening...listening to determine actual needs, so as not to over or under-design.

Overall design considerations (simple or combined cycle; turbine selection; site layout, etc.) are only the beginning. An analysis of plant site's weather data determines the inlet air treatment designs. It also influences material selection for various fabrications (e.g. stainless vs. mild steel).



Construction parameters are carefully developed. Transportation routes of pre-fabricated modules are fully-mapped out. Manufacturing sites, from Braden's extensive international network of fabricators, are selected based on technical expertise, proximity to the installation and any "local content" regulations.



## Engineering Based on Analysis & Real World Experience

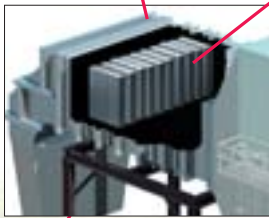
Braden engineers work exclusively on GT plant designs. The engineering disciplines are further specialized into system groups:

- Filter Houses
- Inlet Cooling Systems
- Anti-Icing Systems
- Ductwork/Expansion Joints
- Diverter Dampers
- Silencers
- Exhaust Stacks
- SCR/CO Catalyst Systems

Diverter Damper



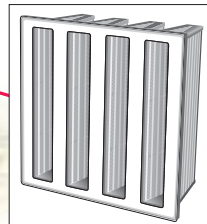
Inlet Ductwork



Inlet Silencer

Inlet Air Cooling Systems

Filter House



Filters

Gas Turbine or Steam Turbine Enclosures (Consolidated Fabricators)

Inlet Air Anti-Icing Systems

Intake Support Structure

## Braden's Engineering Toolbox:

- 3-D Solid Modeling of Complex Shapes
- Computational Fluid Dynamics (CFD)
- Structural Design Analysis
- Thermal, Buckling and Vibration Frequency Analysis
- Finite Elemental Analysis (FEA)
- Acoustical Testing and Analysis

# Filter Houses



Korea – 7FA filter houses



## The Preferred Choice

Braden filter houses are the preferred choice of OEM's for new installations and the favorite choice of GT owners retrofitting their systems. With proprietary designs and numerous global manufacturing locations to satisfy local content requirements, Braden can provide an outstanding solution.

- Filter Houses
- Inlet Cooling / Heating Coils
- Evaporative Coolers
- Over 700 Filter Houses Built



Research and development facility for pulse filter design excellence.

China –  
9FA pulse filter house



USA – SGT6-4000F filter house

## Appropriate Application vs. Site Conditions

Site conditions are a key factor in selecting your optimal solution. Braden pulse (self-cleaning) filtration systems have been engineered to help gas turbines and generators maintain optimum output. Conditions range from desert to industrial to extreme low temperature northern locations. Braden static (barrier) designs offer excellent protection to your turbine or generator within marine, urban, or coastal conditions.



Saudi Arabia – 7EA upflow pulse filter house

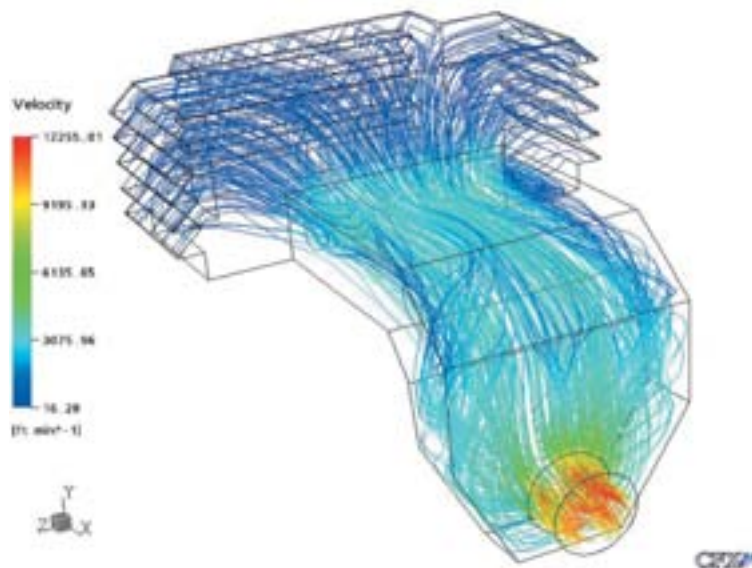


Korea – 501F filter house

# Air Inlet Systems



China – 9FA 90° inlet



CFD analysis of inlet air system velocities, distribution and pressure drop.

## Let Braden Engineer a Superior Inlet System

Designing a great air inlet is all about attention to acoustics and pressure drop. Our experienced staff of acoustical engineers employs the most modern software to provide compliant designs. Computational Fluid Dynamics (CFD) as well as Finite Element Analysis (FEA), 3-D Solid Modeling, and Thermal, Buckling and Vibration Frequency Analysis are applied to guarantee superior pressure drop, distribution and velocities.

## Inlet System Components

- Inlet Plenum
- Inlet Silencers
- Inlet Dampers Doors (Roll Up)
- Inlet Ducting
- Inlet Expansion Joints
- Over 700 Inlet Systems Built



China – 9FA 30° inlet

# Braden Aftermarket Filters & Spare Parts



Aftermarket filters



TriCel(HD)



Cylindrical & conical  
combination filter

**Braden filters** are standard on many OEM-supplied filter houses, because Braden manufactures the highest quality filters for Gas Turbine and Compressor Intake Systems available on the market today!

Braden Filters are approved for all GT classes, including ultra-efficient large frame turbines. Our TriCel™ Final Barrier Filters combine high volumetric air flow and extremely low pressure drop along with the dust-holding capacities required by the newest generation of super efficient GTs. Call us for: prefilters, coalescers, barrier final filters and self-cleaning pulse filters.



Braden expansion joint designs provide extended service life over old designs, often employing ceramic insulation for dramatic temperature reductions. (See page 13 for detail.)



Braden supplies a complete range of aftermarket parts, including gauges, evaporative media liner material, gasket material, insulation / ceramic fiber and hardware kits.

# Exhaust Systems & Diffusers



Qatar – SGT5-4000F exhaust system transport



## The OEMs' Preferred Choice

Braden is a major supplier of gas turbine exhaust stacks and diffusers for turbine original equipment manufacturers. Whether the project is located in our backyard or on the opposite side of the world, Braden is the OEMs' preferred choice. Braden's exhaust system design experience is based on over 1,000 gas turbine exhaust systems and 40+ years of design innovations. For this reason Braden is often selected to design and fabricate the first exhaust components when new turbine models are introduced.



USA – 7FA exhaust system



Qatar – 9FA exhaust system

Indonesia – SGT5-3000E exhaust system

Peru – SGT6-4000F exhaust system



Kuwait –  
SGT5-2000E  
exhaust system

## Diffusers Designed for Severe Conditions

Exhaust diffusers must be designed to withstand severe turbulence at the GT outlet. Braden increases the liner thickness, decreases the spacing on the liner plate supports (scallop bars), and uses smaller liner sheet sizes to provide the most robust liner system possible.

The shell design and support system for the diffusers are carefully engineered to handle the pressure loads.



Italy – SGT5-4000F diffuser assembly

## Exhaust Silencers

- Low frequency design experts
- High reliability
- Long service life

## Exhaust Systems

- Simple-cycle stacks
- Bypass stacks with diverters
- High temperature designs



Qatar – SGT5-4000F exhaust diffuser

# Diverter Dampers



Oman – GT13E2 diverter



## Diverter Experience from the Extreme World of Combined Cycle

Braden has designed and manufactured diverter isolators since 1985. The bulk of our diverter experience is in combined-cycle gas turbine power plants, where extreme and sudden thermal changes necessitate thorough design foresight. We have also designed diverters for desulfurization (FGD) applications with several unique and patented features for improved flow distribution.



Oman – GT13E2 diverter

Qatar – SGT5-4000F  
diverter and exhaust system



Argentina – pre-assembly of SGT5-4000F diverter for functional testing

## High Performance

The requirements for diverter design have multiplied dramatically due to increases in mass flow and exhaust gas temperatures combined with more operating cycles. The Braden Diverter design greatly reduces thermal stress, the cause of damage and leakage. Whether you have the latest high end gas turbine or a smaller unit, we can insure long time reliability and performance.

- “F” Class technology
- High reliability
- FEM analysis of all internal load / thermal stress-related
- Extensive experience
- The OEM’s preferred choice
- Over 2000 diverter dampers built

## Design Features

- Flexible Inconel® seal elements
- Toggle or pivot drive system operation
- Thermal stress-free blade design
- Internal casing insulation
- Delivery in one piece or split into sections as per transportation limits
- Hydraulic power units with HRSG protection mode



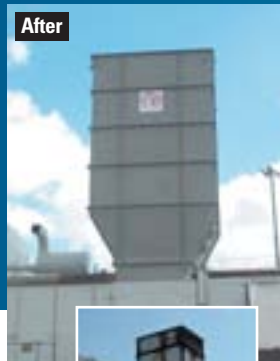
Qatar – 9F toggle linkage mechanism installed on a diverter damper.

Comprehensive

# Retrofit Solutions



Jamaica – FS5 exhaust stack replacement



USA – SGT6-4000F exhaust system



USA – FS5 filter house and exhaust system replacement

## A La Carte or Turnkey

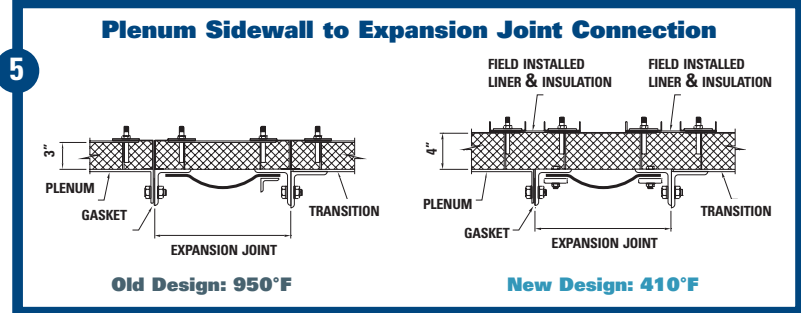
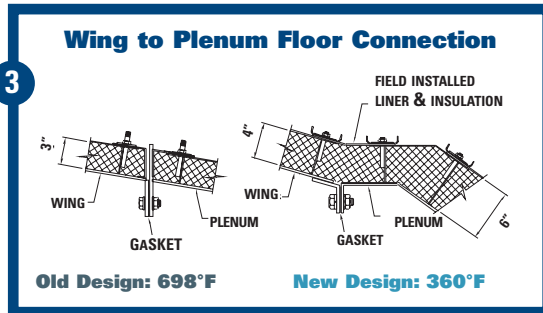
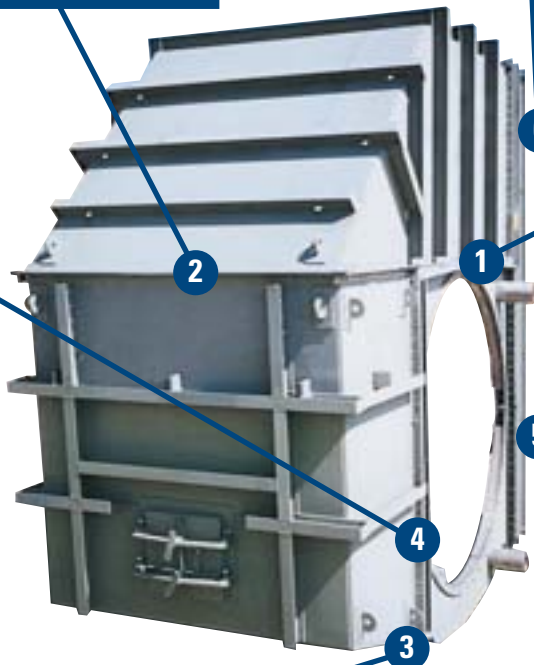
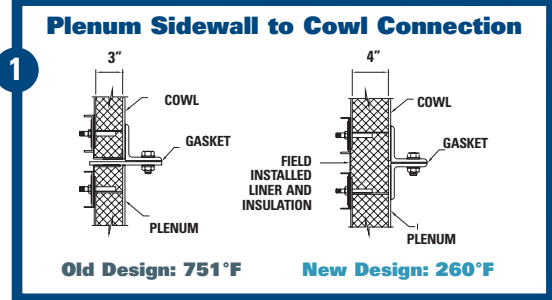
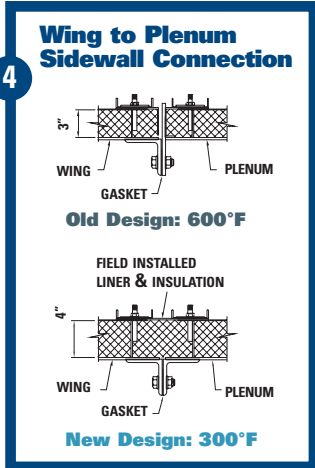
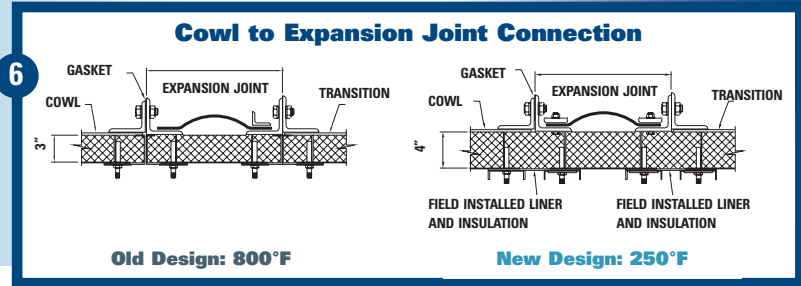
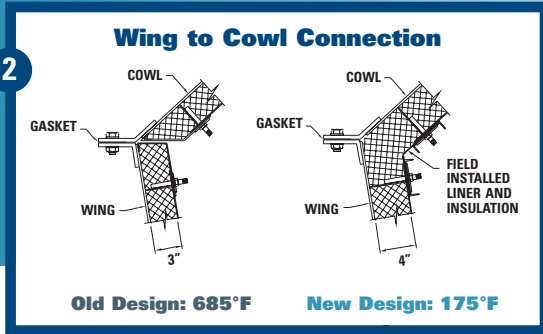
Braden can design a single retrofit system, or build you an entire GT plant from scratch...it's your choice. Braden supplies the necessary financial and logistical data to help you decide on our level of involvement.

## On-Time, On-Budget, On-Target

Braden's supervision of materials, procedures, and personnel means single-source responsibility for each construction event under contract. Our specialized construction knowledge base minimizes erection time and costs, and puts your plant on target to achieve peak power performance as quick as possible.



USA – 7B filter house retrofit



## Exhaust System Design Improvements

Braden has developed new retrofit designs that will drastically reduce external heat transfer, making the Plenum/Wing/Cowl/Expansion Joint area safer, more efficient and easier to operate and maintain. These retrofit designs can be applied to plenums of all sizes.

Let Braden's Retrofit Engineers show you how these design improvements can help

your system. A typical retrofit unit can be installed in one to two weeks during a scheduled maintenance outage, with the diffuser and turbine shaft in place.

Braden offers the manpower, equipment and experience to install on your site...or we can provide detailed erection drawings and procedures for your own crew.

# Consolidated Fabricators



Pressure vessels to ASME U, S and R, PED, CRN and various other international codes

## Build-to-Print or Engineered Systems, Consolidated Fabricators Has Your Solution

Consolidated Fabricators, like Braden, is a Global Power Equipment Group Company. We specialize in the design and manufacture of complex mechanical, electrical and fluid systems, such as Fuel Oil, Fuel Gas, Lube Oil, Water and Air handling systems. We make build-to-print fabrications such as bases, diffusers and plenums as well as small high alloy parts such as seals, shims and brackets.



Fluid system sub-assemblies with piping, vessels and instruments.



Fuel oil piping sub-system with valving and instrumentation for measuring flow, temperature and pressure

We provide one stop shopping for equipment that requires multiple disciplines of fabrication, machining, surface treatments, component integration, piping, vessels and testing. We bring the capability to handle your complex code compliance requirements, Eu, Ce, Atex, PED, IECEX, CSA, CRN, NEX, ASME, ANSI and many others.

Our world class manufacturing facility in Auburn, MA as well as our network of international fabrication partners have helped make us a leading supplier of gas turbine accessory systems.

## Generator Accessories

- Packaged generator cabinet
- Generator collectors
- Hydrogen piping systems
- Hydrogen control panels
- Hydrogen detrainning tanks and piping
- CO<sub>2</sub> expansion systems
- Seal oil systems

## Gas Turbine Accessories

- Fuel Oil and Fuel Gas systems
- Water wash and injection
- Air heating and dehumidification
- Gas and Steam metering tubes



Generator collector housing, a complex assembly with hundreds of parts demonstrates our ability to handle fabrication, machining, specialty part sourcing, assembly and testing.

# NO<sub>x</sub>/CO Catalyst Systems

## World Leading NO<sub>x</sub>/CO Reduction Solutions

Braden can supply a comprehensive NO<sub>x</sub>/CO reduction solution for your simple cycle plant. Drawing on our extensive experience as the world's leader in the design of exhaust silencers and stacks, we now encompass the experience of Deltak, LLC (our sister Global Power Equipment Group company), to offer "complete system" capability:

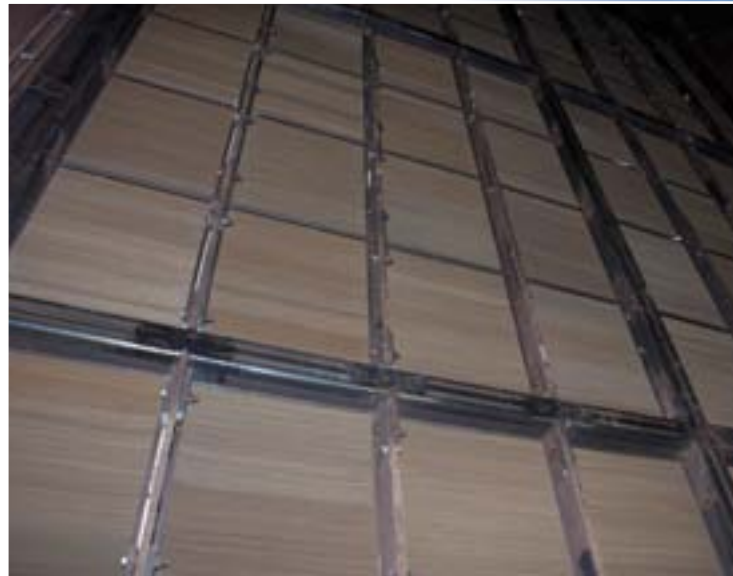
- Flow modeling
- Ammonia systems
- NO<sub>x</sub> and CO catalyst
- Acoustic design / thermal stress analysis
- Catalyst grid design
- Controls



For over a quarter of a century Braden and Deltak have designed and supplied dozens of SCR and CO catalyst systems. Combining our expertise and resources provides industry-leading experience.



Simple cycle SCR and CO system on LM 6000 gas turbine



The combination of SCR technology, coupled with Braden's international fabrication and exhaust structural design expertise is a formula for customer success.



## Manufacturing Locations

- ARGENTINA
- BAHRAIN
- CHINA
- EGYPT
- GERMANY
- INDIA
- INDONESIA
- ISRAEL
- ITALY
- KOREA
- MALAYSIA
- MEXICO
- NETHERLANDS
- POLAND
- ROMANIA
- SAUDI ARABIA
- SPAIN
- THAILAND
- TURKEY
- UAE
- USA



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